Original Research Article

THE USE OF CROP RESIDUES AND HIGH ACTIVITY CLAYS FOR THE MANAGEMENT OF SANDY SOILS FOR SUSTAINABLE RICE PRODUCTION IN SOKOTO, NORTH-WESTERN NIGERIA

Abstract

A field experiment was carried out to assess the effects of various crop residues (rice husk, rice straw, groundnut husk, and millet husk as well as high activity clay (HAC) on some soil properties, growth and yield parameters of rice(*Oryza sativa* L).Sixteen treatment combinations, replicated thrice, were applied at the rates of 5tha^{-1} and 10tha^{-1}each for rice husk, rice straw,millet husk, groundnut husks andhigh activity clay. Results obtained from the field trial as presented in this paper,showed significant effect of some of the treatments on soil chemical parameters especially organic Carbon, available P and exchangeable K. Similarly, soil physical parameters such as texture were also significantly influenced by the treatments. The texture of the soil, which was initially loamy sandy before the incorporation of the amendments,was altered to new textural classes in all the treatments after the experiment.The treatments had significant effects on all the growth parameters except for plant height at four (4) weeks after transplanting. The treatments also had significant effects on all the yield parameters of the test crop (rice).

Key Words: Sandy soils, Crop Residues and High activity clay.

Introduction

Sandy soils are characterized by possession of less than 18% clay and more than 68% sand in the first 100 cm of the column (Brady and Weil, 1999). These soils are often considered as soils with physical properties that are easy to define such as weak structure or no structure, poor water retention properties, low nutrient retention highly sensitive to compaction with many adverse consequences (Bell *et al.*, 2004; Wada, 1996 and Ishida *et al.*, 1993).

Crop residues are plant materials remaining after harvest including leaves, stalks and roots. Their presences on the soil surface decrease erosion, increases organic matter, improve soil quality, increase water holding capacity and infiltration (Lal, 2014). High activity clays have a high cation exchange capacity due to their large surface area. These soils have great capacity to retain and supply large quantities of nutrients such as calcium, magnesium and potassium. They generate high CEC under all soil conditions regardless of soil pH (Masters, 2010).

MATERIALS AND METHODS

Experimental site and materials used

The experiment was carried out at theFadamaTeachingand Research Farm (Lat. 13^{o}.092250N' Long. 5^{o}.208746E, altitude 265m a.s.l.),Faculty of Agriculture,UsmanuDanfodiyo University Sokoto. The soil of the study site belongs to the order Entisols in the USDA Soil Taxonomy system. The soils of the farm are mostly loamy sand in texture. The land was divided into 48 plots each measuring 3m X 3m. Three replicates were used with 1m as spacing between and within rows and laid out in a Randomized Complete Block Design (RCBD) with 16 treatment combinations. The gross plot was 9m^{2}(3m x 3m) with a net plot area of 7.56m^{2} (2.75 X 2.75) and total experimented area of 591.25m^{2} (27.5 X 21.5).

The variety of rice used was Faro 44, which was obtained from National CerealResearch Institute(NCRI) Outstation,BirninKebbi. The high activity clay was obtained from the Inland Valley and flood plains along Illela Road, Sokoto State.

Experimental Layout

The total number of plots was 48 with each measuring 9m^{2} in size and labeled for the various treatments combination i.e. mixture of crop residues and high activity clay at difference rates. The treatments consisted of a factorial combinations of two levels of high activity clay (HAC); 10tha^{-1} and 15tha^{-1} each of which was combined with two level each, 5 tha^{-1} and 10 tha^{-1}, of groundnut shell, rice straw, rice husk and millet husk respectively giving a total of 16 treatment combinations laid out in a Randomized Complete Block Design (RCBD) replicated three times.

Soil analysis

The soil samples were analysis for physical and chemical properties before and after the experiment. Organic carbon was determined by Walkley and Black (1934) method. Total nitrogen was determined by the Microkhjeldal method. Available phosphorus extraction was determined calorimetrically using spectrophotometer as described by Olsen and Sommers

(1982). Textural triangle was used for soil texture determinations. The cation exchange analysis (CEC) of the soil was determined by using pH 7.0 buffer solution of calcium ammonium acetate while ETDA titration was used to measure the Ca^{2+}, Mg^{2+} and K^{+}. Soil pH was measured in both water (1:1) and 0.01m $Cacl_2$ (1:2.5). Particle size distribution was carried out using the hydrometer method.

TREATMENT COMBINATIONS	ACRONYMS)
Groundnut shell 5tha^{-1} + HAC, 10tha^{-1}	G_1HAC_1
Groundnut shell 10 tha^{-1} + HAC 15tha^{-1}`	G_2HAC_2
Rice straw 5 tha^{-1}+ HAC 10tha^{-1}	RS_1HAC_1
Rice straw 10tha^{-1} + HAC 15tha^{-1}	RS_2HAC_2
Rice husk 5tha^{-1} + HAC 10tha^{-1}	RH_1HAC_1
Rice husk 10tha^{-1} + HAC 15tha^{-1}	RH_2HAC_2
Millet husk 10tha^{-1} + HAC 10tha^{-1}	MH_1HAC_1
Millet husk 10tha^{-1}+ HAC 15tha^{-1}	MH_2HAC_2
Groundnut shell 5tha^{-1} + HAC 15tha^{-1}	G_1HAC_2
Groundnut shell 10 tha^{-1} + HAC 10tha^{-1}	G_2HAC_1
Rice straw 5tha^{-1} HAC + 15tha^{-1}	RS_1HAC_2
Rice straw 10tha^{-1} + HAC 10tha^{-1}	RS_2HAC_1
Rice husk 5tha^{-1} + HAC 15tha^{-1}	RH_1HAC_2
Rice husk 10 tha^{-1} + HAC 10tha^{-1}	RH_2HAC_1
Millet husk 5tha^{-1} + HAC 15tha^{-1}	MH_1HAC_2
Millet husk 10tha^{-1} + HAC 10tha^{-1}	MH_2HAC_1

RESULTS AND DISCUSSION

The results of soil analysis before the experiment are presented in table 1. The particle size analysis revealed that the soil is loamy sand in texture, slightly acidicand low in organic matter, CEC and available phosphorus. The results indicate that; pH values based on the ratings by Chude*et al.* (2011), ranged from acidic with mean values of 5.2 (1:1 soil water ratio) and pH measured in $CaCl_2$ (1:1 soil solution ratio) was 4.5. Exchangeable cations (Ca, Mg, K, Na) were low.

The treatments had significant ($P< 0.05$) on soil pH both in water and $CaCl_2$. The initial pH recorded before the experiment was 5.3 and 4.5 for pH (H_2O) and pH ($CaCl_2$) respectively. (Table 3) This shows the pH was strongly acidic (Chude*et al.*, 2011). The pH value recorded on MH_2HAC_2 (7.3) which is slightly alkaline for pH (H_2O) and 7.0 neutral for pH ($CaCl_2$). The significant increase in the soil pH on all treatments might be because of the release of basic cations by the crop residues(Vanlauwe*et al.*, 1994).

The results from table 3 shows that treatments significantly ($P<0.05$) influenced soil organic matter. Treatment G_2HAC_2 recorded the highest value. Ashrif and Thornton (1965) found out that the incorporation of groundnut residue will provide organic matter and other plant nutrients in the soil. Groundnut being a legume has the ability to fix atmospheric nitrogen which is directly related to increased organic matter in the soil.

Resultsin table 3 showed that the treatments had significant effect on nitrogen. Treatment G_2HAC_1 recorded the highest total nitrogen. Anderson and Peterson (1973) found out that the groundnut residues can be incorporated to provide nitrogen for non-leguminous crops such as rice. The water holding capacity of the clay might have aided the soil in conserving and releasing nutrients (Ashrif and Thornton, 1965).

All the treatments (Table 3) had significant effect on CEC. Treatment RH_1HAC_2 had the highest CEC (11.83 $Cmolkg^{-1}$) Singh *et al.* (1980) reported that application of rice residues and manure resulted in increased CEC.

The treatments had significant effect on available phosphorus. The initial value of available P before the experiment ($4.6mgkg^{-1}$) was low (Esu, 1991). Treatment RH_1HAC_2 recorded the highest value of Available Phosphorus. Brady and Weil (1999) reported that, clays that possess greater anion exchange capacity (due to positive surface charges) have a greater affinity for phosphorus ions.

The results in Table 3 indicated that all the treatments had significant effects on exchangeable calcium. Treatment RH_1HAC_2 gave the highest value (3.6cmolkg^{-1}). Generally there was an increase in exchangeable calcium in all treatments. This is supported by the findings of Ahmad (2015).

All thetreatments had significant effects on exchangeable Magnesium.Treatment (RH_2HAC_2) recorded the highest value. It was observed that exchangeable magnesium increased with increase in clay content (Roychand and Marschner, 2013).

The treatments had significant effect on exchangeable potassium. The highest value was recorded by treatment RH_2HAC_2.Kaur and Benepal (2006) reported an increase in available K and water soluble K as a result of incorporation of rice residue and farm yard manure.

The exchangeable sodium was significantly ($P<0.05$) affected by the treatments. Treatment RS_2HAC_1 recorded the highest value (0.26cmolkg-1). This value is low according to the rating of Esu (1991).

Electrical conductivity (EC) was significantly affected by the treatments. The EC value of the soil before the experiment was 0.27ds/m. Treatment RS_2HAC_1 recorded the highest value of EC (1.7 dS/m). The soils of the study area were generally non-saline, based on the rating of Landon(1991) who reported that soils of EC levels of 0-2dS/m are salt free soils.

The data on textural classes of the treatments is presented in table 2. The initial texture of the soil before the experiment (Table 1) was Loamy sand. As can be seen from Table 2, all the textural classes of the 16 treatments were altered. All treatments where 10tha^{-1} high activity clay was incorporated had their textural class altered to Loamy while all treatments where 15tha^{-1} high activity clay was incorporated changed to clay loam. This is irrespective of the type of crop residue that was combined with the high activity clay. This confirmed the assertion that soil texture is a fixed property that can only be changed by the addition of one soil separate or the other (Hall*et al.*, 2010).

The tiller count of rice inTable 4 was significantly affected by the treatments. Treatment RH_2HAC_2 recorded the highest tiller per stand. The result obtained may be attributed to an improved soil moisture retention condition as a result of higher rate of rice husk and clay. This assertion was earlier stated by Muktar*et al.* (2015). The treatments did not significantly ($P>0.05$) affect plant height at 4 weeks after transplanting (WAT). However, plant height was significantly ($P<0.05$) affected at 8 and 12 weeks after transplanting.

Treatment RH_1HAC_2 recorded the highest value both at 8 and 12 weeks after transplanting. This is in agreement with the work of Lal (1997) who found that application of rice husk combined residues produced the highest plant height.

The effect of crop residue and HAC on the number of spikes in rice is presented in Table 4. The treatments had significant ($P<0.05$) effect on the number of spikeletper spike.Treatment RH_2HAC_2 recorded the highest value with a mean of 15.00. This was attested by Ogboghodo*et al.* (2018), whose results showed that nutrient uptake increased as the rate of application of rice husk and clay increased. The number of grains per spike (Table 4) was significantly ($P<0.05$) influenced by the treatments.Treatment RH_2HAC_2 recorded the highest number of grains per spike. This was earlier confirmed by Hall *et al.* (2010) who found that the addition of 15 t/ha clay to sandy top soil increased number of grains per spike in rice. The treatment had significant effecton grain yield. RH_1HAC_2 recorded the highest grain yield. This may be attributed to the high quality of N, K, Mg and Ca as attested by Muktar*et al.*(2015).

Roychand and Marschner(2013) also found that the amending sandy soil with rice husk and clay rich subsoil could increase grain yield in wheat. The treatments had significant ($P<0.05$) effect on straw yield of rice. Gupta (2002) reported high straw yield in rice where rice husk amended was combined with 8 t/ha clay. The treatments had significant ($P<0.05$) effect on one thousand (1000) grain weight. Treatment RH_2HAC_2 recorded the highest value of one thousand (1,000) grain weight. This was supported by findings of Sanderman and Baldock (2010) who recorded a similar result. They reported that the high magnesium ($0.36 cmolkg^{-1}$) and Calcium ($0.61 cmolkg^{-1}$) as being responsible for high yield in one thousand (1000) grain weight. Schweizer*et al.* (1999) reported increased soil organic carbon retention and a high one thousand grain weight where rice residues amendments were used in rice cultivation. This finding is in confirmity with Oghoghodo*et al.* (1995) who found out that the incorporation of rice crop residues as being superior over removal or burning of crop residue practices possibly due to improved physical, chemical and biological properties of soils due to increase organic carbon content in the soil.

CONCLUSION

The results of the study showed that all the treatments had a significant effect on chemical and physical parameters of the soil. Also most of the chemical and physical parameters such as organic carbon, phosphorus, potassium EC, CEC, pH increased at the end of the experiment. However sodium level in the soil decreased. Also, all the textures of the soils before the experiment (Loamy sand) were completely altered in the 16 treatments. This was a result of addition of various rates of clay to the soil.This wasirrespective of the quantity of crop residue applied. The treatments had significant effects on the plant height (8 and 12 weeks after transplanting), number of tillers, number of spikeletsperspike, number of grains per spikelet, straw yield grain yield and one thousand 1000 grain. Treatment RH_2HAC_2 proved to be the best among the 16 treatments.

Table 1: Physical and chemical properties of the soil before the experiment

Soil Property	
Sand (%)	70
Silt (%)	22
Clay (%)	8
Textural class	Loamy sand
pH (H_2O) 1:1	5.3
pH ($CaCl_2$) 1:1	4.5
EC(dS/m)	0.27
Org.matter (g kg^{-1})	12.7
Total N (g kg^{-1})	0.95
Org.C (g kg^{-1})	5.02
Av. P (mg kg^{-1})	4.6
CEC (Cmol kg^{-1})	9.2
ExchCa (Cmol kg^{-1})	1.55
Exch Mg (Cmol kg^{-1})	1.36
Exch K (Cmol kg^{-1})	0.80
Exch Na (Cmol kg^{-1})	1.6

Table 2: Particle Size Distribution at the end of the Experiment

Treatment	% Sand	% Silt	% Clay	% Textural Class
G_1HAC_1	50	30	20	Loam
G_1HAC_2	36.4	33.4	30.2	Clay Loam
G_2HAC_1	49	31	20	Loam
G_2HAC_2	40.4	24.4	35.3	Clay Loam
MH_1HAC_1	49.4	31.1	20.2	Loam
MH_1HAC_2	42.4	22.4	35.2	Clay Loam
MH_2HAC_1	44.3	35.3	20.4	Loam
MH_2HAC_2	36.4	33.3	30.3	Clay Loam
RH_1HAC_1	50	29	21	Loam
RH_1HAC_2	30.2	39.4	30.4	Clay Loam
RH_2HAC_1	49.4	31.1	20.2	Loam
RH_2HAC_2	39	31	30	Clay Loam
RS_1HAC_1	51	29	20	Loam
RS_1HAC_2	24	40	36	Clay Loam
RS_2HAC_1	50	30	20	Loam
RS_2HAC_1	32.4	25.3	33.3	Clay Loam

Table 3: Effect of crop residues and high activity clay on soil physical and chemical properties of the soil

TRT	pH (H_2O 1:1)	pH ($CaCl_2$ 1:1)	CEC (Cmol kg^{-1})	EC (dS/m)	Ca (cmol kg^{-1})	Mg (cmol kg^{-1}	K (cmol kg^{-1})	Na (cmol kg^{-1})	O.C g kg^{-1}	O.M g kg^{-1}	N (g kg^{-1})	Avail P (mg/kg^{-1})
RH_2HC_2	6.933^{hi}	6.867^{ab}	11.83^{a}	0.5733^{h}	2.143^{c}	12.200^{a}	0.9700^{c}	0.1160^{e}	24.10^{h}	68.70^{h}	0.6667^{d}	7.633^{a}
RH_1HC_2	6.833	5.700^{f}	11.80^{a}	1.1867^{bc}	3.633^{a}	4.567^{b}	0.5500^{g}	0.1740^{e}	40.33^{a}	41.93^{n}	0.6300^{de}	8.000^{a}
RS_2HC_2	6.933^{hi}	6.867^{ab}	11.07^{b}	0.5733^{h}	2.143^{c}	2.333^{j}	0.5600^{g}	0.2167^{b}	26.67^{g}	46.13^{l}	0.6667^{d}	5.567^{cde}
RH_2HC_1	6.967^{fh}	6.867^{ab}	10.77^{c}	0.9367^{e}	2.210^{c}	3.667^{i}	0.8133^{de}	0.1737^{c}	33.13^{e}	47.37^{k}	0.6067^{e}	6.667^{b}
G_2HC_2	7.267^{a}	6.967^{a}	10.27^{d}	0.8300^{f}	2.400^{bc}	3.727^{ef}	0.7500^{e}	0.1343^{d}	39.20^{ab}	69.20^{a}	0.7333^{c}	4.800^{ef}
G_2HC_1	7.153^{bcd}	6.833^{ab}	10.22^{d}	1.0267^{d}	2.133^{c}	4.233^{c}	0.8333^{d}	0.1313^{d}	36.23^{d}	62.77^{e}	0.9667^{a}	51.133^{def}
RS_2HC_1	7.167^{abcd}	6.867^{ab}	10.17^{d}	0.5667^{h}	2.117^{c}	2.860^{h}	0.8133^{de}	0.2673^{a}	27.27^{g}	47.37^{k}	0.7667^{c}	5.433^{ef}
G_1HC_2	7.137^{cd}	6.433^{cde}	9.97^{e}	0.9033^{e}	2.627^{b}	3.700^{f}	1.1000^{b}	0.1723^{c}	38.47^{bc}	67.37^{c}	0.8433^{c}	47.33^{ef}
RH_1HC_1	6.867^{ij}	6.067^{ef}	9.83^{f}	0.7133^{g}	2.227c	3.830^{de}	0.5500^{g}	0.1740^{c}	30.20^{f}	52.23^{h}	0.6767^{d}	6.667^{b}
G_1HC_1	7.067^{def}	6.533^{bcd}	9.77^{f}	1.1333^{c}	2.133^{c}	3.500^{g}	0.6600^{f}	0.0863f	35.80^{d}	63.63^{d}	0.8467^{c}	4.867^{ef}
RS_1HC_1	7.000^{efgh}	6.867^{ab}	9.71^{f}	1.6800^{a}	3.470^{a}	3.750^{def}	0.5500^{g}	1737^{c}	27.87^{g}	48.13^{j}	0.7667^{c}	5.267^{def}
RS_1HC_2	7.067^{defg}	6.800^{abc}	9.71^{f}	0.3200^{i}	3.633^{a}	2.610^{i}	0.6533^{f}	0.2647^{a}	24.10^{h}	41.93^{n}	0.7367^{c}	5.133^{def}
MH_2HC_2	7.233^{abc}	7.000^{a}	9.57^{g}	0.5467^{h}	2.217^{c}	3.853^{d}	0.5433g	0.1743^{c}	26.70^{g}	43.13^{m}	0.6400^{de}	5.733^{cd}
MH_1HC_1	7.067^{def}	6.900^{ab}	9.24^{h}	1.1733^{c}	2.133^{c}	2.667^{i}	0.5133^{g}	0.1747^{c}	37.67^{c}	68.50^{b}	0.7333^{c}	6.233^{bc}
MH_2HC_1	7.253^{ab}	7.033^{a}	9.17^{h}	0.6800^{g}	2.243^{c}	3.683^{f}	0.5667^{g}	0.1750^{c}	29.90^{f}	51.53^{i}	0.6733^{d}	5.700^{cd}
MH_1HC_2	7.077^{de}	6.333^{de}	8.21^{i}	1.2433^{b}	2.233^{c}	2.583^{i}	0.6400^{f}	0.1743^{c}	34.27^{e}	59.83^{f}	0.6400^{de}	6.200^{bc}
P	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
S. E	0.03240	0.0324>	0.0458	0.03073	0.1083	0.03985	0.02243	0.001113	0.435	0.001	0.01555	0.2165

Means followed by the same letter (s) within the same column are statistically the same at 5% level of probability using Duncan's New Multiple Range Test (DNMRT).

KEY:

TREATMENT COMBINATIONS	ACRONYMS)
Groundnut shell 5tha^{-1} + HAC, 10tha^{-1}	G_1HAC_1
Groundnut shell 10 tha^{-1} + HAC 15tha^{-1}`	G_2HAC_2
Rice straw 5 tha^{-1}+ HAC 10tha^{-1}	RS_1HAC_1
Rice straw 10tha^{-1} + HAC 15tha^{-1}	RS_2HAC_2
Rice husk 5tha^{-1} + HAC 10tha^{-1}	RH_1HAC_1
Rice husk 10tha^{-1} + HAC 15tha^{-1}	RH_2HAC_2
Millet husk 10tha^{-1} + HAC 10tha^{-1}	MH_1HAC_1
Millet husk 10tha^{-1}+ HAC 15tha^{-1}	MH_2HAC_2
Groundnut shell 5tha^{-1} + HAC 15tha^{-1}	G_1HAC_2
Groundnut shell 10 tha^{-1} + HAC 10tha^{-1}	G_2HAC_1
Rice straw 5tha^{-1} HAC + 15tha^{-1}	RS_1HAC_2
Rice straw 10tha^{-1} + HAC 10tha^{-1}	RS_2HAC_1
Rice husk 5tha^{-1} + HAC 15tha^{-1}	RH_1HAC_2
Rice husk 10 tha^{-1} + HAC 10tha^{-1}	RH_2HAC_1
Millet husk 5tha^{-1} + HAC 15tha^{-1}	MH_1HAC_2
Millet husk 10tha^{-1} + HAC 10tha^{-1}	MH_2HAC_1

Table 4: Effect of crop residues and high activity clay on growth parameters of rice in Sokoto

Treatment	Tiller Number (M^2)	Plant height (cm) 4WATP	Plant height (cm) 8 WATP	Plant height (cm) 12 WATP
G_1 HAC_1	39.67^{bcde}	31.00^{a}	58.67^{cd}	70.33^{gh}
G_2 HAC_1	39.33^{bcde}	32.33^{a}	62.33^{bcd}	70.67^{g}
RS_1 HAC_1	38.33^{bcde}	34.00^{a}	64.67^{abcd}	82.33^{ef}
RS_2 HAC_1	37.00^{cde}	33.67^{a}	67.33^{abc}	87.00^{de}
RH_1 HAC_1	31.33^{e}	31.67^{a}	70.33^{ab}	94.00^{bcd}
RH_2 HAC_1	41.00^{abcde}	32.33^{a}	71.00^{ab}	98^{abc}
MH_1 HAC_1	35.67^{cde}	33.33^{a}	55.67^{d}	68.67^{gh}
MH_2 HAC_1	40.00^{bcde}	31.67^{a}	59.00^{cd}	71.33^{gh}
G_1 HAC_2	40.67^{abcde}	32.33^{a}	56.33^{cd}	69.67^{gh}
G_2 HAC_2	39.67^{bcde}	32.33^{a}	56.33^{cd}	73.00^{gh}
RS_1 HAC_2	32.67^{de}	32.67^{a}	56.33^{cd}	89.00^{de}
RS_2 HAC_2	34.67^{cde}	34.33^{a}	62.33^{bcd}	91.00^{cd}
RH_1 HAC_2	48.33^{ab}	33.67^{a}	73.67^{a}	99.00^{ab}
RH_2 HAC_2	50.67^{a}	33.67^{a}	71.00^{ab}	102.67^{a}
MH_1 HAC_2	42.33^{abcd}	32.33^{a}	56.00^{cd}	66.33^{h}
MH_2 HAC_2	43.33^{abc}	32.00^{a}	58.67^{cd}	75.67^{fg}
Significance	*	NS	*	*
SE	3.101	2.231	3.351	2.46
P – Value	0.010	0.832	0.002	0.001

Means followed by the same letter (s) within the same column are statistically the same at 5% level of probability using Dunca's New Multiple Range Test (DNMRT).
* = Significant at 5% level of probability
NS = Not significant at 5% level probability

Table 5: Effect of crop residues and high activity clay on yield parameters of rice in Sokoto

Treatment	Number of Spikes	Number of grains perspike	Grain yield Kgha^{-1}	Straw yield Kgha^{-1}	One thousand grain weight (g)
G_1 HAC_1	7.667^{def}	9.00^{de}	3.883^{cd}	8.623^{cd}	23.07^{efg}
G_2 HAC_1	6.33^{f}	11.00^{bcde}	3.330^{cd}	11.330^{bc}	23.73^{ef}
RS_1 HAC_1	6.667^{ef}	9.33^{cde}	4.700^{cd}	8.440^{cd}	22.80^{efg}
RS_2 HAC_1	9.00^{bcde}	8.33^{e}	4.623^{cd}	8.293^{ed}	27.33^{cd}
RH_1 HAC_1	8.667^{bcd}	8.67^{e}	8.143^{b}	10.923^{bc}	30.50^{bc}
RH_2 HAC_1	9.667^{bcd}	12.33^{abcd}	8.477^{b}	13.367^{b}	32.50^{b}
MH_1 HAC_1	6.667^{f}	9.33^{cde}	2.623^{cd}	7.997^{cd}	19.87^{g}
MH_2 HAC_1	8.33^{cdef}	11.00^{bcde}	2.070^{d}	7.030^{d}	20.83^{fg}
G_1 HAC_2	9.333^{bcd}	10.00^{cde}	4.147^{de}	6.923^{d}	23.30^{efg}
G_2 HAC_2	9.333^{bcd}	12.00^{abcd}	4.183^{cd}	6.477^{d}	25.43^{de}
RS_1 HAC_2	10.333^{bc}	8.33^{e}	3.810^{cd}	8.589^{cd}	27.43^{cd}
RS_2 HAC_2	11.000^{b}	10.33^{bcde}	4.993^{c}	8.107^{cd}	28.53^{cd}
RH_1 HAC_2	13.667^{a}	13.33^{ab}	9.587^{ab}	13.513^{b}	30.67^{bc}
RH_2 HAC_2	15.00^{a}	15.00^{a}	11.683^{a}	17.773^{a}	38.17^{a}
MH_1 HAC_2	9.667^{bcd}	11.00^{bcde}	3.290^{cd}	8.067^{cd}	21.40^{fg}
MH_2 HAC_2	10.000^{bcd}	11.00^{bcde}	2.827^{cd}	7.140^{d}	21.72^{fg}
Significance	*	*	*	*	*
SE	0.726	0.982	0.798	1.057	1.130
P – Value	0.001	0.001	0.001	0.001	0.001

Means followed by the same letter (s) within the same column are statistically the same at 5% level of probability using Dunca's New Multiple Range Test (DNMRT).
* = Significant at 5% level of probability
NS = Not significant at 5% level probability

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